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(12) UK Patent Application (19) GB (11) 2 166 512 A

(43) Application published 8 May 1986

(21) Application No 8427945

(22) Date of filing 5 Nov 1984

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(51) INT CL^4
F16L 59/02 F01N 7/14 7/16 F16L 59/14

(52) Domestic classification
F2P 1A35 1B2 1B3 1B7B 1B7F 1B7L 1B7W 1B8 C12
F1B 2A9C F214 F259 F320 FB
U1S 1851 F1B F2P

(56) Documents cited
GB 1342310 GB 1107550

(58) Field of search
F2P
Selected US specifications from IPC sub-classes F16L
F01N

(54) Thermally insulated conduits

(57) A method of heat insulating a high temperature conduit (2) such as an exhaust system comprises wrapping around at least a portion of the conduit an insulating mat of fibrous material (3) e.g. ceramic or glass capable of withstanding temperatures of 400°C or more and forming a sleeve (5) of resilient polymeric material e.g. silicone or fluorocarbon over the fibrous material, which polymeric material is capable of withstanding temperatures of 100°C or more. The polymeric material is preferably applied as a sheet of curable polymeric material wrapped around the fibrous material to compress the fibrous material and held in place by a temporary wrapping of nylon tape during curing. Ceramic or polymeric end caps 7 may be provided.

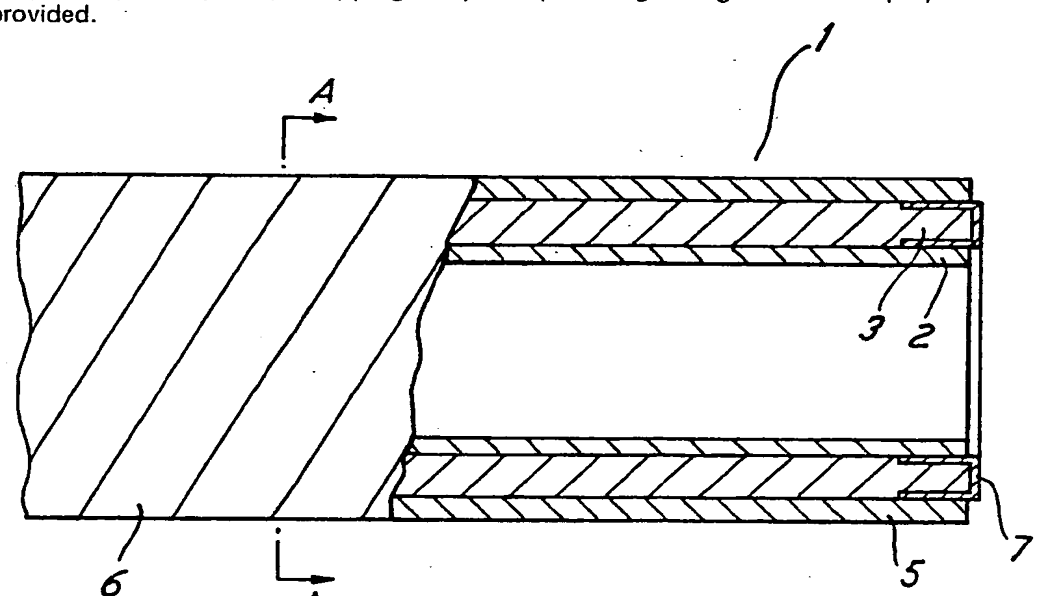

FIG.1

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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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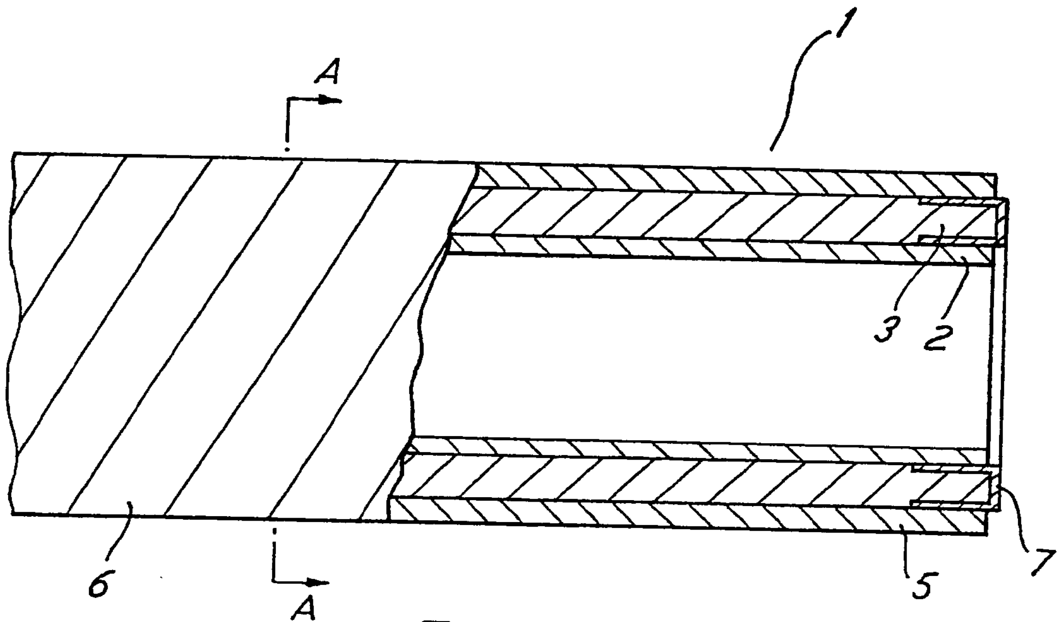

FIG.1

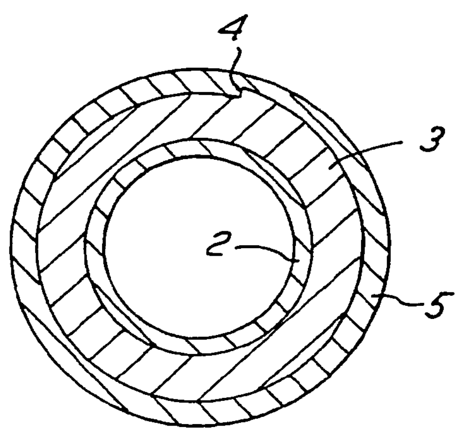

FIG.2

SPECIFICATION

High temperature fluid flow conduits

The present invention relates to conduits for high temperature fluid flow such as exhaust systems.

Exhaust systems and in particular exhaust pipes within engine compartments of motor vehicles reach very substantial temperatures in use. The tendency at present is for these temperatures to increase.

The temperature of the exhaust pipes of a conventional motor vehicle having a normally aspirated engine in the general vicinity of the exhaust manifold is typically around 700°C. In exhaust turbine supercharged engines (turbo charged engines) which are becoming increasingly popular the exhaust pipes in this area may well reach over 1000°C. Not only is the use of such turbo charging systems increasing but to minimise aerodynamic drag, the undersides of vehicles are being designed in such a way as to reduce under vehicle air turbulence and hence to reduce the general flow of cooling air around the engine compartment.

The high temperature of exhaust pipes and other parts of the exhaust systems of motor vehicles often prevents other components of the vehicle being placed in the ideal position. For instance, brake fluid reservoirs and hoses must be kept sufficiently far from the hot exhaust pipes to prevent the brake fluid overheating. Electronic components are generally heat sensitive and must be positioned sufficiently far away from the exhaust system. As exhaust system temperatures rise, the difficulty of positioning such components increases.

Catalytic converters are increasingly being employed in exhaust systems to minimise exhaust emissions. Such converters normally require a relatively high exhaust temperaure for efficient operation and accordingly it is desirable to prevent heat being lost from the exhaust system upstream of the converter.

Accordingly, attempts have been made to insulate exhaust systems or portions thereof to prevent heat escaping from the exhaust system.

The insulation materials considered most suitable are of a fibrous nature and form loose, non-woven mats. Difficulty arises in binding these fragile materials in place against the exhaust system components such as the exhaust pipes. Attempts have been made to retain the insulating material by wrapping in fabric. This has proved unsatisfactory in use and the insulating material has had a surprisingly short life time before being burned through by the heat of the exhaust. Attempts have also been made to enclose the insulation material in an outer metal casing over the exhaust pipes but this has proved impractical or prohibitively costly. Atlernative methods of insulating exhaust systems such as wrapping with asbestos rope or fitting metal heat deflecting shields have also proved unsatisfactory.

The present invention provides a method of heat insulating a high temperature conduit such as an exhaust system comprising wrapping around at least a portion of the conduit an insulating mat of fibrous material capable of withstanding temperatures of 400°C or more and forming a sleeve of resilient polymeric material over the fibrous material, which polymeric material is capable of withstanding temperatures of 100°C or more.

The invention includes a conduit for high temperature fluid flow, eg. an exhaust system or a portion thereof, comprising an inner conduit having over at least a portion of its length an intermediate layer of fibrous heat insulation material and an outer sleeve of flexible polymeric heat resistant material, the heat resistance of the insulating material and the flexible polymeric material being as described above.

Preferably, the mat of fibrous material is non-woven.

Preferably, the fibrous material is capable of withstanding temperatures of 750°C or more, eg. 1000°C or more. Suitable fibrous materials include mineral fibres, in particular ceramic fibres such as kaolin fibres. Such fibres are available as non-woven mats under the name TRITON-KAOWOOL from Morgan Ceramic Fibres Limited. Glass fibres will not generally have adequate high temperature characteristics for use in the invention but it is possible to specially treat glass fibres to render them more heat resistant. For instance, it is known to treat glass fibres with finely divided platelets of aluminosilicate, thus raising their temperature resistance from about 300°C to 1000°C. Such treated glass fibres may be used in accordance with the present invention. Their preparations described in British Patent Specifications 1593382, 1593383 and European Patent Specification 44160 A1.

Preferably the polymeric material is capable of withstanding temperatures of 150°C or more, eg. 200°C or more.

Preferably, the polymeric material is resistent to mineral oils and motor vehicle fuels such as petrol and diesel. Generally, the polymeric material need not be stable against immersion in such materials but should be stable against vapour and splashes of such materials.

Generally, silicone rubbers have satisfactory properties. The properties of fluro carbon rubbers as regard heat resistance and resistance to oils and fuels are generally superior but the higher

cost of such materials and the greater difficulties in compounding them will generally make such materials less preferred for most applications.

Preferably, the method according to the invention includes wrapping a sheet of curable polymeric material around the fibrous material and curing the polymeric material to form a unitary sleeve surrounding the fibrous material.

Perferably, the polymeric material is such as to be curable by heat. For instance, silicone rubbers compounded with peroxides such as 2,4-dichlorobenzoyl peroxide may be cured in this way, for instance by heating to a temperature of about 140°C for 30 minutes.

The sheet of curable polymeric material may suitably be held in place prior to curing to form a unitary sleeve by overwrapping with a suitable wrapping material such as a tape stable at curing temperatures. For instance, nylon tape may be wrapped helically over the wrapping of curable polymeric material. The tape may be removed after the curing process.

Preferably, the fibrous insulation material is compressed beneath the sleeve of resilient polymeric material, for instance, to occupy from 25% to 75%, eg. 50%, of its original volume.

We have established that at least part of the reason for the early failure of laggings of fibrous insulation material overwrapped with fabric is the penetration of organic materials such as oils and fuel into the fibrous material where it appears to carbonise and form a heat conduction path destroying the insulation value of the materials and causing the outer wrapping to be heated excessively and degraded. A benefit of the present invention described above is that the resilient polymeric sleeve overlying the fibrous material forms a barrier to the penetration of the insulation material by oils and fuels. To further protect the insulating material, it is preferred that the fluid flow conduits according to the present invention be provided at one or both ends of the intermediate layer of fibrous, non-woven heat insulating material with means for excluding ingress of contaminants such as oils and fuels Preferably, said means for preventing ingress of contaminants may comprise a cuff covering the annular end of the insulating material layer. It will generally not be necessary that this cuff be able to withstand immersion in contaminants. Generally, it will be sufficient to prevent ingress of contaminants to the insulating material for the cuff to provide sufficient of a barrier to prevent wicking of contaminant materials into the insulating material in response to splashes of contaminant or contaminant vapour in the surrounding atmosphere. Suitably, such protective cuffs may be made from fabric capable of withstanding the temperatures to which the inner conduit will be exposed in use, eg. of withstanding 400°C or more. Such a fabric may be made by weaving material of the same nature as forms the insulation material mat surrounding the inner conduit. Alternatively, a mouldable heat resistance composition may be applied over the end of the intermediate layer. For instance, ceramic fibre treated with sodium salicylate forms a mouldable putty like material which hardens on heating. This may be used to form a protective cuff as described above. Other heat resistant mouldable compositions may be employed.

A degree of protection against contamination may even be obtained by enclosing the end of the intermediate layer in a silicone rubber of the kind suitable for use in the polymeric sleeve. In contact with the inner conduit, this will be degraded into a ceramic material but this may nonetheless provide an adequate barrier to contaminants.

Preferably, the means for preventing ingress of material is flexible or elastic so as to be resistant to failure due to vibration.

The invention includes an exhaust system or an exhaust system component such as an exhaust silencer, tail pipe, stack or exhaust pipe having over a part of its length or over its whole length an insulation as described above.

The invention will be illustrated by the following description of a preferred embodiment with reference to the accompanying drawing in which

Figure 1 is a partially sectioned view of a fluid flow conduit according to the invention and;

Figure 2 is a cross-section through the conduit of Fig. 1 along the line A–A.

As shown in Figs. 1 and 2, a portion of an exhaust pipe 1 comprises as its inner layer a conventional metal exhaust pipe 2. Wound around the exhaust pipe 2 is an intermediate layer 3 of a non-woven mat of ceramic fibre insulating material. This is wrapped over the exhaust pipe 2 as a sheet and butted along a join line 4. A sheet of uncured silicone rubber 5 is wraped over the insulating material 3 and slightly overlapped along the joining line. The silicone rubber contains 2,4-dichlorobenzoyl peroxide as a curing agent by means of which it may be heat cured. After heat curing, for instance, in an oven at 140°C for approximately 30 minutes, the silicone rubber forms a unitary sleeve over the insulating material 3 and is entirely bonded together where it overlapped itself.

To retain the silicone rubber in place during the heat curing, a winding of nylon tape 6 is applied over the silicone rubber 5. After heat curing this winding may be removed. Generally, this will result in an impression of the nylon tape being left in the outer surface of the silicone rubber forming an attractive surface pattern serving to provide a good grip when handling the resulting exhaust pipe. Preferably therefore, the tape is provided with a raised surface pattern such as ribs or a diaper pattern.

Preferably, the fibrous material 3 is compressed during the process of applying the silicone rubber sheet and the winding of the nylon tape such as to have a thickness approximately half what it could be in the absence of compression.

As shown in Fig. 1, a cuff 7 of e.g. woven ceramic fibre cloth may be slipped over the exhaust pipe before the insulating material is applied and folded back over the insulating material. The silicone rubber may then be applied thereover.

Such a cuff helps to exclude contaminants from the insulating material.

The following table shows the temperatures of the exhaust pipe, the interface between the ceramic fibre and the exterior silicone rubber sleeve and the exterior of the silicone rubber sleeve for different values of the exhaust pipe tempertured. Figures are given for three different thicknesses of ceramic fibre insulation.

TABLE

Insulation Thickness 3mm

Exhaust Pipe Temperature (°C)	450	400	350
Interface Temperature (°C)	261	220	179
Exterior Sleeve Temperature (°C)	210	180	150

Insulation Thickness 12.5mm

Exhaust Pipe Temperature (°C)	750	700	650	600	550	500	450
Interface Temperature (°C)	239	220	204	185	165	143	120
Exterior Sleeve Temperature (°C)	195	180	169	155	140	123	105

Insulation Thickness 25mm

Exhaust Pipe Temperature (°C)	1050	1000	950	900	850	800	750
Interface Temperature (°C)	232	219	205	193	185	172	159
Exterior Sleeve Temperature (°C)	190	180	170	160	155	145	135

In each case the thickness of the silicone rubber sleeve was 2mm. It can be seen that using the method of insulation according to the invention, it is possible to reduce the exterior temperature of an exhaust pipe being heated as its interior to 1,050°C to only 190°C. This prevents high engine compartment temperatures and enables the heat of the exhaust gases to be retained for the better operation of catalytic converters or exhaust gas turbine superchargers.

Generally, it will not be necessary to provide the whole of an exhaust system with insulation according to the invention although this can be done if desired. Generally, it will be sufficient to provide the insulation over portions of the exhaust system, particularly the exhaust pipes.

An additional advantage of maintaining the temperature of the exhaust gas by preventing heat loss from the exhaust system by using insulation as described above is that there is a lesser tendency for corrosive substances to condense in the exhaust system.

In some exhaust systems, eg. for trucks, the exhaust pipes are led behind the drivers cab into a vertical stack. The heat radiated by the stack can raise the temperature in the cab uncomfortably posing a serious safety hazard. Such stacks may be lagged by the method according to the invention.

Encapsulating the insulation material within a flexible polymeric substance having adequate heat resistance as described above overcomes shortcomings of the insulation material such as its friability and low mat strength. In particular, silicone rubber is a flexible covering, having a high strength, long life (at least 10 years at temperatures below 200°C) and resistance to chipping and chunking from stones thrown up from the road whilst a vehicle is in motion.

An additional benefit of the use of the present invention in relation to exhaust systems is a considerable degree of sound deadening being achieved.

Whilst the invention has been described with particular reference to exhaust systems, the invention will be applicable in other situations in which high pipe temperatures have undesirable consequences, particularly in environments where there is exposure to contaminants which, upon heating, will degrade the heat insulation effect which would be obtained from an unshielded lagging of insulation.

Many modifications and variations are possible of the invention as described herein without

departing from the scope of the invention.

CLAIMS

1. A method of heat insulating a high temperature conduit comprising wrapping around at least a portion of the conduit an insulating mat of fibrous material capable of withstanding temperatures of 400°C or more and forming a sleeve of resilient polymeric material over the fibrous material, which polymeric material is capable of withstanding temperatures of 100°C or more.

2. A method as claimed in Claim 1 wherein the mat of fibrous material is non-woven.

3. A method as claimed in Claim 1 or Claim 2 wherein the fibrous material is capable of withstanding temperatures of 750°C or more.

4. A method as claimed in Claim 3 wherein the fibrous material is composed of mineral fibres.

5. A method as claimed is Claim 4 wherein the mineral fibres are ceramic fibres.

6. A method as claimed in Claim 3 wherein the fibrous material is composed of glass fibres treated to render them heat resistant to temperatures of about 1000°C.

7. A method as claimed in any preceding claim wherein the polymeric material is capable of withstanding temperatures of 150°C or more.

8. A method as claimed in any preceding claim wherein the polymeric material is resistant to mineral oils and motor vehicle fuels sufficiently to be stable against vapour and splashes of such materials.

9. A method as claimed in Claim 8 wherein the polymeric material is a silicone rubber.

10. A method as claimed in any preceding claim wherein the sleeve of polymeric material is formed by wrapping a sheet of curable polymeric material around the fibrous material and curing the polymeric material to form a unitary sleeve surrounding the fibrous material.

11. A method as claimed in Claim 10 wherein the sheet of curable polymeric material is held in place prior to curing to form a unitary sleeve by overwrapping with a suitable wrapping material stable at curing temperatures.

12. A method as claimed in any preceding claim wherein the fibrous insulation material is compressed beneath the sleeve of resilient polymeric material.

13. A method as claimed in Claim 12 wherein such compression is such that the fibrous material occupies from 25 to 75% of its original volume.

14. A method of heat insulating a high temperature conduit substantially as hereinbefore described with reference to the accompanying drawings.

15. A conduit for high temperature fluid flow, comprising an inner conduit having over at least a portion of its length an intermediate layer of fibrous heat insulation material and an outer sleeve of flexible polymeric heat resistant material, the heat resistance of the insulating material and the flexible polymeric material being as defined in Claim 1.

16. A conduit as claimed in Claim 15 provided at one or both ends of the intermediate layer of fibrous, non-woven heat insulating material with means for excluding ingress of contaminants such as oils and fuels.

17. A conduit as claimed in Claim 16, wherein said means for preventing ingress of contaminants comprises a cuff covering the annular end of the insulating material layer.

18. A conduit as claimed in Claim 17 wherein the cuff is formed from a fabric made by weaving material of the same nature as forms the insulation material mat surrounding the inner conduit.

19. A conduit as claimed in Claim 17 wherein the cuff is a mouldable heat resistant composition applied over the end of the intermediate layer.

20. A conduit as claimed in any one of Claims 15 to 19 which is an exhaust system or an exhaust system component.

21. A conduit for high temperature fluid flow substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

Printed in the United Kingdom for Her Majesty's Stationery Office, Dd 8818935, 1986, 4235.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.